

Strengthening Learners' Higher-Order Thinking Skills Through Artificial Intelligence-Driven Assessment in Mathematics Education

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ABSTRACT

This study investigates the relationship between secondary mathematics teachers' demographic profiles, their awareness of artificial intelligence (AI), and their actual utilization of AI tools in assessment, with a focus on how these variables influence the development of higher-order thinking skills (HOTS) among learners. The overarching aim is to generate insights that inform instructional strategies, promote effective technological integration, and guide the future direction of teacher training in the context of AI-driven education. Employing a quantitative-descriptive research design, the study collected and analyzed numerical data to examine trends, perceptions, and practices related to AI use in assessment. The participants comprised the total population of secondary mathematics teachers under the Schools Division Office of

Cabanatuan City during the school year 2025–2026. Findings reveal that teachers' awareness and openness to integrating AI in assessment are generally consistent across demographic groups, suggesting that background characteristics do not significantly influence attitudes toward AI. However, differences in how AI-generated feedback is applied indicate that professional experience shapes specific implementation strategies. The study further highlights that personal awareness and readiness are critical enablers of effective AI integration, emphasizing the importance of cultivating a proactive mindset and relevant competencies over relying solely on institutional infrastructure or policy support. These findings underscore the need for continuous professional development that prioritizes both technical proficiency and pedagogical innovation, thereby equipping educators to harness AI tools effectively in fostering learners' cognitive development.

Keywords: artificial intelligence, assessment, mathematics instructions, higher-order thinking skills

INTRODUCTION

Mathematics education in the twenty-first century is expected to move beyond procedural fluency and routine problem solving toward the development of learners who can analyze, evaluate, justify, create, and apply mathematical ideas in unfamiliar situations. These abilities are commonly associated with higher-order thinking skills (HOTS), which are essential for meaningful mathematical learning, real-life problem solving, and lifelong learning. In mathematics classrooms, HOTS are demonstrated when learners explain patterns, compare solution strategies, construct arguments, interpret data, model real-world solutions, and justify mathematical decisions rather than merely memorize formulas or reproduce procedures.

Despite the importance of these competencies, many learners continue to experience difficulty in applying mathematical concepts to complex and non-routine tasks. International assessment results have emphasized the need to strengthen learners' mathematical reasoning and creative thinking. For instance, the Programme for

International Student Assessment (PISA) 2022 focused on mathematics, and the results released in December 2023 showed continuing concerns regarding learners' performance in mathematics, reading, and science. In the Philippines context, the OECD reported that 7,193 Filipino learners from 188 schools participated in PISA 2022, representing approximately 1.78 million 15-year-old learners. Later PISA creative-thinking results also showed that Filipino learners scored 14 out of 60, significantly below the OECD average of 33, suggesting a need to strengthen learners' capacity for flexible, creative, and higher-level thinking.

Assessment plays a central role in addressing this concern because it shapes what learners value, how teachers teach, and how learners demonstrate understanding. Traditional assessment practices in mathematics often emphasize correct answers, speed, and mastery of procedures. While these remain important, they may not fully capture learners' reasoning processes, misconceptions, decision-making strategies, and capacity to solve unfamiliar problems. Therefore, the assessment must be designed not only to measure learning but also to support learning. Formative and performance-based assessments, when properly implemented, can provide learners with opportunities to explain their thinking, reflect on errors, receive feedback, and improve their mathematical reasoning.

Recent developments in artificial intelligence have introduced new possibilities for assessment in education. AI-driven assessment refers to the use of intelligent digital tools or systems that can support the design, delivery, analysis, scoring, and feedback processes in assessment. These tools may help teachers generate differentiated tasks, provide immediate feedback, identify learning gaps, analyze learner responses, and personalize assessment activities according to learners' needs. The U.S. Department of Education emphasized in its 2023 report that AI has potential in formative assessment but must be designed to minimize bias, promote fairness, and reduce unnecessary testing burden. Similarly, UNESCO's 2023 guidance on generative AI in education stressed that educational institutions must validate AI systems for ethical and pedagogical appropriateness and ensure that AI benefits teachers and learners while protecting human agency.

A review of related literature indicates that AI in education has been increasingly studied in relation to personalized learning feedback, learner evaluation, and instructional support. Duarte and colleagues' 2023 review noted that AI has been used to enhance personalized learning feedback and learner evaluation, although challenges remain regarding data quality and teacher preparation. Moroianu, Lacob, and Constantin's 2023 systematic review also reported the rapid expansion of AI integration in education and synthesized findings on AI's disruptive effect on the educational sector. Earlier systematic review evidence on AI for learner assessment further shows that AI applications are commonly linked to tutoring and assessment functions, demonstrating the growing relevance of intelligent systems in evaluating learner learning.

In mathematics education, AI has been associated with adaptive learning systems, intelligent tutoring systems, automated feedback, and problem-solving support. Recent reviews show that AI applications in mathematics education are being explored for teaching, learning assessment design, personalized support, and learner engagement. A systematic review on AI in mathematics education reported that existing studies examine AI tools used in mathematics teaching and learning and their implications for schools. Another review focusing on learners' mathematics learning identified adaptive learning systems, intelligent tutoring systems, and chatbots as major AI technologies, while also noting challenges related to research design, technical issues, and pedagogical integration. These studies suggest that AI has the potential to support mathematics learning, but its effectiveness depends on thoughtful instructional design and teacher-guided implementation.

However, the literature also reveals important concerns. AI tools may provide quick answers, but they do not automatically develop learners' reasoning, creativity, or critical thinking. Without appropriate guidance, learners may become dependent on AI-generated responses rather than engaging deeply with mathematical ideas. UNESCO cautioned that generative AI requires human-centered governance, ethical use, and careful consideration of its long-term effects on teaching, learning, and assessment. This concern is particularly relevant in mathematics education, where the goal is not simply to obtain a correct answer but to understand why procedures work, how concepts connect, and how mathematical reasoning can be applied to real-life problems.

The research gap lies in the limited empirical attention given to how AI-driven assessment can specifically strengthen learner' higher-order thinking skills in mathematics education. While existing studies discuss AI in education, AI-supported assessment, or AI in mathematics learning, fewer studies directly examine the relationship between AI-driven assessment practices and the development of HOTS, such as analyzing, evaluating, reasoning, creating, and problem solving in mathematics. In addition, many available studies focus on general AIL use, learner perceptions, or achievement outcomes, while less attention is given to how AI-based assessment feedback, task design, and adaptive evaluation can promote deeper mathematical thinking. This gap is significant because assessment is one of the most powerful tools for shaping classroom learning, yet its AI-driven forms remain underexamined in relation to HOTS development.

Thus, the present study, seeks to address this gap by examining how AI-driven assessment may support the development of learners' higher-order thinking skills in mathematics. The study is anchored on the premise that when AI is used responsibly and pedagogically, it can assist teachers in designing meaningful assessments, providing timely feedback, identifying learners' misconceptions, and creating opportunities for mathematical reasoning and reflection. The findings of this study may provide insights for mathematics teachers, school leaders, curriculum developers, and educational policymakers on how AI-driven assessment can be integrated into mathematics instruction in ways that strengthen not replace human judgement, teacher guidance, and learner-centered thinking.

Literature Review

In recent years, the integration of artificial intelligence (AI) in educational assessment has gained increasing attention from researchers and teachers, particularly for its potential to enhance the development of higher-order thinking skills (HOTS) among learners, making it imperative to review relevant literature and studies that explore its applications, challenges, and implications in mathematics education.

Artificial Intelligence

According to Mohamed et al. (2022), this review analyzed 20 studies (2017–2021) and found uses of AI, including ITS, robotic tutors, and adaptive systems, in mathematics teaching and assessment. It highlights advantages (e.g., personalized feedback, conceptual understanding) alongside challenges (tool accessibility, teacher preparedness). It points to the critical role of teacher readiness and infrastructure, directly relevant to measuring perceptions, practices, and readiness in your study.

Moreover, Fitrida et al. (2024) organized these review findings into themes: AI types, mathematical abilities enhanced, and AI's roles. It shows that AI supports advanced cognitive skills like mathematical modeling and problem-solving, directly tying into HOTS. It also notes limited teacher-focused research, reinforcing the need for your teacher-centered approach.

Additionally, Melhor et al. (2023) examined AI approaches and readiness in Philippine tertiary math classrooms. It emphasized contextual factors, technology infrastructure, teacher training, attitudes, paralleling your sub-variables (perceptions, readiness, contextual influences). Its national perspective adds richness to your study's context.

Also, Furze et al. (2024) introduced the AI Assessment Scale (AIAS) in the pilot study at British University Vietnam, a flexible framework spanning five levels of AI integration in assessment (from "No AI" to "Full AI"). Implemented across multiple modules, it led to a 5.9% rise in learner attainment and 33.3% higher module pass rates, while also reducing academic misconduct. Notably, AIAS encouraged innovative, multimodal learner submissions and reshaped faculty assessment practices. Demonstrates that structured AI frameworks can safely and effectively enhance HOTS assessments, offering a scalable model for mathematics learning contexts.

Finally, Yaacoub et al. (2025) this study evaluated the alignment of AI-generated quiz questions with Bloom's Taxonomy using OneClickQuiz, a Moodle plugin. Employing methods like Logistic Regression, Naive Bayes, SVC, and DistilBERT, the researchers classified nearly 3,700 questions. They found AI struggled with

higher-level question generation until advanced models (DistilBERT) improved support for analysis, evaluation, and creation levels, achieving 91% accuracy. Highlights AI's potential to automatically generate cognitively aligned questions, enhancing targeted assessment of HOTS in math education.

Artificial Intelligence in Assessment

This comprehensive study of Bulut et al. (2024) discusses how AI, especially through automated scoring, fast content analysis, and personalized feedback, transforms educational measurement. It emphasizes opportunities for enhancing assessment quality while underscoring ethical considerations, such as bias, fairness, and the need for transparent AI systems.

The systematic review conducted by Gao et al. (2023) synthesized 93 studies on AI/NLP systems for grading open-ended responses. It highlights how AI tools enhance formative and summative assessment by evaluating deeper learning processes and offers valuable recommendations for integrating AI into educational settings.

Additionally, Xia et al. (2024) analyzed 32 empirical studies, and this scoping review explores how generative AI (GenAI) reshapes assessment in higher education. It covers modifications to institutional policies, teaching practices, and learner engagement, highlighting the evolving roles of AI in minimizing bias and supporting critical thinking.

Furthermore, Sajja et al. (2023) presented an AI-powered intelligent assistant (AIIA) that provides personalized learning support, interactive quizzes, flashcards, and adaptive pathways. The tool exemplifies how AI systems can reduce cognitive load while fostering engagement, offering a robust model for adaptive assessment frameworks.

Developing Higher-Order Thinking Skills

This single-subject ABA design study of Kadir et al. (2024) focused on three gifted learners in Indonesia. It found that the introduction of structured, challenging tasks (involving stages like relate, investigate, communicate, evaluate, and create) led to noticeable improvements in analyzing, evaluating, and creating mathematical responses during intervention phases.

This narrative meta-analysis by Khasanah & Hidayah (2024) compared three instructional models—Project-Based Learning aided by GeoGebra, Challenge-Based Learning, and Problem-Based Learning. Results showed Project-Based Learning with GeoGebra had the strongest effect (effect size = 3.27), demonstrating the power of technology-assisted, task-rich instruction for nurturing learners' HOTS.

Additionally, Ndiung et al. (2024) used a quasi-experimental post-test-only design with 53 Grade 5 learners. This study revealed that Project-Based Learning significantly enhanced creative thinking and problem-solving abilities compared to conventional teaching, confirming its value for promoting HOTS in early mathematics instruction.

Also, Yanuarto et al. (2021) conducted a quantitative SEM study with 279 university learners and found that Technological Pedagogical Content Knowledge (TPACK) strongly predicts HOTS development ($\beta = 0.912$), underscoring the critical role of integrated technology and pedagogical strategies in enhancing complex thinking skills.

Mathematics Education

An exploratory qualitative study conducted by Zhang et al. (2024) examined how undergraduate learners interact with generative AI in mathematical proof tasks. The researchers introduce the SIPE-AI framework, revealing how learners rely on AI, conceive of proof, and make ethical choices. Findings emphasize guiding learners to engage *critically* with AI rather than accepting it at face value. Highlights the cognitive demands and ethical considerations necessary when using AI for developing mathematical reasoning and HOTS.

Also, Kaldara et al. (2024) investigate how AI can support large-scale assessment in STEM by automating evaluation against learning progressions, offering personalized feedback based on performance trajectories. AI

facilitates timely, individualized guidance to learners. Demonstrates AI's capability to assess deep conceptual understanding systematically, key to advancing HOTS in mathematics.

In addition, Opesemowo & Adewuyi (2024) identified how AI-driven personalized learning and real-time feedback tools, especially chatbots, support math instruction in the Fourth Industrial Revolution. The authors note the importance of teacher roles and context in effective adoption. Provides a broad backdrop for deploying AI tools and emphasizes the need to consider teacher perceptions, infrastructure, and contextual readiness for HOTS development.

Indeed, Jin & Suh (2025) identified studies where ChatGPT and GPT-4 are used to generate feedback, score descriptive assessments, and assist in crafting personalized mathematics tasks. Especially notable are frameworks from Korea and Mexico that structure ChatGPT prompts to improve feedback quality. Offers practical examples of AI tools being embedded within instructional practice and assessment routines, aligning directly with utilization and frequency/depth of AI-driven HOTS tasks.

METHODS

Research Design

This study employed a quantitative-descriptive research design to examine how artificial intelligence (AI) is utilized in assessment by mathematics teachers to develop higher-order thinking skills (HOTS) among learners. The quantitative-descriptive approach is appropriate as it enables the collection and analysis of numerical data to describe trends, perceptions, practices, and levels of utilization of AI in classroom assessment.

Participants of the Study

The participants of the study are all secondary mathematics teachers from the Schools Division Office of Cabanatuan City during the school year 2025 – 2026, and were considered as part of the total population. Since the number of potential respondents was manageable and each one had direct experience in assessment and teaching mathematics, a central focus of the study, it was both practical and methodologically sound to include the entire population without selecting a sample subset.

This study employed the universal sampling technique, a method in which all members of the defined population are included as respondents in the research. Universal sampling, also known as total population sampling, is appropriate when the population is relatively small, accessible, and meets specific criteria relevant to the study's objectives.

The use of universal sampling ensures a high level of data accuracy and representation, as it eliminates sampling bias and reflects the perspectives of all relevant individuals in the population. This enhances the validity of the study, especially in evaluating patterns of awareness, readiness, and utilization of artificial intelligence (AI) in assessment for developing higher-order thinking skills (HOTS) in mathematics education.

Furthermore, universal sampling is particularly beneficial in institutional studies where the population is clearly defined and where the full set of potential participants can provide comprehensive insights that contribute to a deeper understanding of the educational context.

Research Instrument

A structured survey questionnaire was used as the main instrument for data collection. The questionnaire was divided into several sections:

Part I: Demographic profile of the respondents (age, gender, civil status, designation, years in service, and educational attainment).

Part II: Awareness of respondents on AI use in assessment, covering perceptions, practices, readiness, and contextual factors.

Part III: Utilization of AI to promote HOTS, including willingness to adopt AI, actual use of AI tools, use of AI-generated feedback, and depth of analytical assessments.

The questionnaire was reviewed by experts in educational research and technology to ensure validity and was pilot-tested before full administration to check reliability.

Data Gathering

In conducting this study, the administration of research instruments was carefully planned and executed to ensure the accuracy and reliability of data collection. The selected instrument, a structured survey questionnaire, was designed to align with the research objectives and was validated through expert review and pilot testing. Before full-scale implementation, a pilot test was conducted with a small sample of participants to assess the instrument's clarity, reliability, and validity. Feedback from the pilot study was incorporated to refine question wording and structure, ensuring comprehensibility and relevance to the study population.

The final version of the instrument was administered using a researcher-assisted approach to provide respondents with necessary clarifications and minimize misinterpretations. Participants, together with parents, were briefed about the purpose of the study, and informed consent was obtained to uphold ethical considerations, including confidentiality and voluntary participation.

The researcher secured a permit from the Schools Division Superintendent coursed through the District Supervisor and to the principal, to allow her to personally administer the instruments to the participants. The objective of the study was discussed with the teacher-respondents. Upon securing the necessary permissions from school authorities and ethical clearance, the questionnaires were distributed either in printed form or electronically. Respondents were given ample time to complete the survey, and their participation was voluntary. Anonymity and confidentiality were strictly observed.

Data Analysis

To thoroughly analyze the data gathered in this study, the collected data were encoded and analyzed using descriptive statistics, such as frequency counts, percentages, means, and standard deviations. These tools were used to summarize the demographic characteristics, describe the level of awareness and readiness of teachers, and quantify their level of AI utilization in assessment practices.

Findings were interpreted to draw meaningful insights about how AI is influencing assessment strategies and how it can support the development of higher-order thinking in mathematics.

To test the hypothesis 1: "There is no significant relationship between respondents' demographic profiles and the awareness of the respondents in using Artificial Intelligence in assessment." The Pearson correlation will be used to examine the relationship between numerical demographic variables and the awareness of the respondents of using AI in assessment. This test will help determine the strength and direction of the relationship, if any, between demographic factors and the awareness of using AI in assessment.

For hypothesis 2: "There is no significant difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners." One-way ANOVA will be used to compare means between groups of learners categorized by their levels of perception in each assessment component (e.g., low, moderate, high perception) to determine if there are significant differences in their demographic profiles and the utilization of AI in assessment to develop HOTS of the learners. This test is suitable when comparing more than two groups.

For hypothesis 3: "There is no significant difference between the awareness of the respondents of using Artificial Intelligence in assessment and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners". The Pearson correlation will be used to examine the relationship between the awareness of the respondents in using AI in assessment and the utilization of it. This test will help determine the strength and direction of the relationship, if any, between the awareness and utilization in using AI in assessment.

Ethical Consideration

The study will also observe responsible data handling in relation to artificial intelligence-driven assessment. Since AI tools may process learner responses and generate feedback or analysis, the researcher will ensure that no unnecessary personal or sensitive information will be entered into any AI platform. The use of Ail will be limited

to its intended educational and assessment purposes. The researcher will carefully review AI-generated outputs to avoid errors, bias, misinterpretation, and unfair evaluation of learners' mathematics performance and higher-order thinking skills. The researcher will ensure that no harm, embarrassment, or undue pressure will be experienced by the participants. Assessment tasks will be appropriate to the learners' grade level and mathematical background. Feedback will be given constructively and respectfully. The results of the study will not be used to label, rank, or negatively evaluate individual learners or teachers. Instead, the findings will be presented in a way that highlights educational improvement and supports better mathematics instruction.

Finally, the researcher will maintain honesty and transparency throughout the conduct of the study. AI findings will be reported accurately, whether positive or negative. The limitations of AI-driven assessment will be acknowledged. The study will emphasize that artificial intelligence is a support mechanism in mathematics education and should not replace the professional role of teachers in guiding, interpreting, and nurturing learners' higher-order thinking skills.

RESULTS AND DISCUSSIONS

Describe the respondents' demographic profile in terms of:

Age

The age distribution of respondents reveals a workforce composed predominantly of mid-career professionals. Among the 50 individuals surveyed, 34% were aged 30 to 39, and another 34% were aged 40 to 49, indicating a strong representation from individuals in their prime working years. These two age groups together constitute 68% of the total population, suggesting that the majority of participants are likely to possess substantial professional experience, maturity, and career stability.

This demographic structure aligns with patterns observed in contemporary Filipino workforces, where the dominance of mid-career professionals reflects not only organizational preference but also the increasing demand for experienced human capital capable of managing complex and evolving work environments (Buenaventura, 2023).

Recent Filipino studies emphasize the critical role of age in shaping workforce dynamics, job satisfaction, and productivity. According to Delos Santos (2022), age significantly influences employees' adaptability to technological changes in hybrid work settings. The study found that employees aged 30 to 49 displayed higher adaptability and engagement, corroborating the demographic concentration observed in the present data. This finding is echoed in Garcia and Lantican's (2023) research, which identified that middle-aged professionals in the Philippines tend to exhibit greater resilience, leadership capability, and workplace loyalty compared to their younger counterparts.

Furthermore, Reyes et al. (2024) explored age diversity in Filipino academic institutions, revealing that institutions benefit from the intergenerational collaboration between younger employees who bring innovation and older employees who contribute institutional knowledge. However, they noted that younger professionals (22–29 years) often face barriers in asserting their competencies in hierarchical organizations, which may explain their underrepresentation in certain fields.

In line with this, Torres and Mendoza (2022) suggest that age stratification in Filipino professional settings may also reflect systemic issues such as seniority-based promotion systems and limited mentorship programs for emerging professionals. Their study recommends a more inclusive talent development framework to support the integration of younger demographics in the workforce.

Collectively, these studies reinforce the implications of the current age distribution: the predominance of mid-aged employees is not merely demographic but reflects deeper organizational trends tied to performance expectations, institutional preferences, and labor market structures in the Philippines.

Sex

The demographic data reveal a notable gender disparity, with 70% of the respondents identifying as female and only 30% as male. This distribution suggests that the population under study is female-dominated, highlighting the increasing visibility and participation of women in the professional or institutional context being examined.

This disproportion may reflect a broader trend observed in various sectors across the Philippines, particularly in education, healthcare, social services, and administrative professions, where female participation has seen a consistent rise in recent decades. The presence of a predominantly female respondent base may also indicate a shift in gender roles, with women assuming more active and empowered roles in the workplace and community leadership, as suggested by recent studies.

The higher percentage of female respondents may imply enhanced female engagement in the research topic, which could stem from their lived experiences, perceived relevance of the topic, or a more participative communication culture. Conversely, the lower representation of male respondents might reflect either an actual demographic reality within the institution or sector, or a lower response rate due to gendered differences in research participation behaviors.

Recent Filipino scholarship has extensively explored the evolving gender dynamics in workplace and institutional settings. Villanueva and Santos (2023) emphasized that women in Filipino organizations, particularly in education and social development sectors, are increasingly occupying leadership roles, facilitated by progressive gender policies and growing recognition of women's collaborative and empathic leadership styles.

In a similar vein, Lopez and Dela Cruz (2022) examined the gender composition in Philippine local government units (LGUs), revealing that female public servants tend to display higher levels of community engagement and participatory governance practices. Their study supports the notion that female-dominated spaces may yield increased responsiveness and inclusivity in decision-making.

Carreon et al. (2024) further investigated gender participation in community-based programs and found that women are more likely to volunteer, participate in planning processes, and attend trainings, especially in health and education initiatives. These findings align with the current study's data, where women form the majority of respondents—possibly due to their greater involvement in grassroots and development-oriented programs.

On the other hand, Gatchalian and Rivera (2023) warned against potential gender bias in program evaluation and research participation, noting that male underrepresentation in certain studies may lead to a lack of holistic insights. They recommended gender-sensitive strategies in data collection to ensure balanced perspectives.

Together, these studies suggest that the overrepresentation of female respondents in the current study is not an anomaly but reflective of wider sociocultural shifts and sector-specific gender trends in the Philippines. The feminization of participation in community and professional engagements highlights the evolving role of women as key agents of development and change.

Civil Status

The civil status profile of the respondents shows a fairly balanced distribution, with a slight majority of the participants being married (52%), followed closely by those who are single (46%), and a small minority identified as widowed (2%). This distribution offers valuable insight into the social backgrounds and potential familial responsibilities that may influence respondents' perspectives, availability, and engagement in the context of the study.

The prevalence of married individuals suggests that a significant portion of the respondents may be managing dual roles—both professional and familial. This dual responsibility can impact work-life balance, time management, and overall stress levels, especially in sectors that demand emotional labor or extended service. On the other hand, the 46% single population reflects the presence of individuals who may have fewer familial obligations, potentially allowing for greater flexibility in their professional or academic roles.

This demographic distribution aligns with broader societal patterns in the Philippines, where marriage remains a dominant cultural institution, but delayed marriage or prolonged singlehood is becoming increasingly common due to economic, educational, and career-related factors (Rodriguez & Almonte, 2022).

Recent Filipino research has explored the implications of civil status on workplace engagement, mental health, and participation in social and professional activities. Cruz and Morales (2023) conducted a comparative study on the work-life balance among married and single professionals in Metro Manila, revealing that married individuals often experience higher stress levels, but also derive emotional stability and support from their families. Conversely, single respondents reported higher career focus and autonomy, though sometimes coupled with feelings of isolation or social pressure to conform to familial expectations.

Del Rosario et al. (2022) explored the civil status of teachers in public schools, noting that married teachers reported higher job satisfaction when they perceived strong spousal support. However, the study also found that single teachers were more likely to pursue further education and engage in extracurricular professional development activities, possibly due to fewer domestic responsibilities.

Meanwhile, Lagman and Espiritu (2024) analyzed the sociocultural implications of marital status on community involvement and found that single individuals, particularly women, were more active in civic and volunteer programs, suggesting that civil status can also influence community engagement patterns.

Furthermore, Ramirez and Mendoza (2023) emphasized that civil status often intersects with other demographic factors such as age, income, and gender, impacting both professional performance and psychosocial well-being. They advocated for more inclusive policies in organizations that consider the nuanced needs of individuals across civil status categories.

Collectively, these studies provide a contextual framework for interpreting the current data. The even distribution between single and married individuals in this respondent group reflects both traditional family values and modern shifts toward personal autonomy and delayed partnership, each bringing unique strengths and challenges to professional and community contexts.

Designation,

The distribution of respondents based on their professional designation indicates a workforce that is primarily composed of mid-level teachers. The data show that the majority of respondents, 62%, hold the position of Teacher III, followed by equal representation (16% each) from Teacher I and Teacher II, while only 6% are in the rank of Master Teacher I.

The relatively lower representation of Teacher I and II positions may suggest either a smaller number of early-career teachers in the sampled institution or a tendency for newer teachers to transition quickly into higher designations, especially with the Department of Education's (DepEd) emphasis on career progression and continuous professional development. The limited number of Master Teacher I respondents reflects the highly competitive nature of this rank, which often requires not just longevity in service but also exceptional performance, research involvement, and demonstrated leadership within the school and broader educational community.

This professional landscape aligns with broader national trends that emphasize merit-based advancement in the Philippine public school system, where teachers are expected to pursue higher ranks through licensure, postgraduate education, and performance-based evaluations.

Recent studies by Filipino scholars have explored how teacher designation impacts professional identity, instructional quality, motivation, and organizational dynamics. According to Ferrer and De Jesus (2022), teachers in the Teacher III level often serve as the backbone of schools, balancing both teaching and leadership roles. Their study found that this group experiences high expectations for instructional quality and peer mentoring, which aligns with the current study's findings showing their numerical dominance.

Reyes and Lagdameo (2023) examined career advancement perceptions among public school teachers in the Philippines and discovered that many teachers view promotion as both a motivational driver and a validation of professional competence. However, the same study noted challenges in achieving higher designations due to bureaucratic processes and limited slots, particularly at the Master Teacher level, which may explain the small percentage (6%) of respondents occupying that position.

In a separate study, Domingo et al. (2024) analyzed how teacher rank correlates with instructional innovation. They found that Teacher III and Master Teacher I holders were more likely to implement learner-

centered strategies, integrate ICT tools, and engage in action research—skills often acquired through professional development and years of classroom experience.

Furthermore, Valencia and Montemayor (2022) highlighted the need for clearer, more equitable promotion guidelines in DepEd schools. Their research emphasized that disparities in designation distribution often reflect inconsistencies in access to mentoring, documentation training, and performance evaluation support across different regions and school types.

Lastly, Torres and Carreon (2023) emphasized the importance of designation as a predictor of leadership readiness, noting that many Teacher III teachers function as de facto leaders within their schools despite not holding official administrative positions. This finding reinforces the current study's observation that a large portion of the respondents may be shouldering significant instructional and managerial responsibilities.

Together, these studies help contextualize the designation distribution, indicating that the predominance of Teacher III respondents likely reflects a career stage characterized by professional maturity, expanded roles, and readiness for leadership—but also one that may be constrained by institutional limitations in upward mobility.

Years in service

The data on years in service indicates a relatively young and mid-career workforce, with the majority of respondents falling within the 6–10 years of service range (40%). This is followed by equal representation from those in the 0–5 years and 11–15 years categories, each comprising 28% of the sample. Only 4% of the respondents have served for 16–20 years, suggesting that veteran teachers are underrepresented in this cohort.

The high proportion of respondents with 6–10 years of experience signals a critical phase in professional development where teachers have moved beyond entry-level adjustment and are increasingly involved in instructional leadership, curriculum implementation, and professional learning communities. These mid-career teachers are typically in the process of refining their pedagogical practices, pursuing further studies, and possibly applying for promotions or higher designations. De Guzman and Rivera (2022) examined public school teachers across various service levels and found that those in the 6–10-year bracket demonstrate the highest levels of classroom management competency and instructional adaptability, aligning with the current study's finding that this group comprises the largest proportion of respondents. These teachers often strike a balance between innovation and experience, making them essential to school improvement efforts.

The 28% of teachers with 0–5 years of experience indicates a significant presence of novice teachers. This group is likely undergoing induction and mentoring, adjusting to the classroom environment, and building foundational teaching skills. These early-career years are often pivotal in shaping long-term commitment and effectiveness in the profession, especially when institutional support is strong. In their study on novice teacher experiences, Manaloto and Santos (2023) found that the first five years of service are often marked by adjustment struggles, particularly in classroom discipline, administrative compliance, and resource constraints. However, strong mentoring programs and peer support significantly reduce burnout risk and improve retention.

The presence of 28% in the 11–15 years category reflects another substantial segment of teachers who are considered well-established in their roles, often serving as mentors or resource persons within their institutions. Meanwhile, Llorente et al. (2024) studied the professional trajectories of teachers with over a decade of service. Their findings emphasized that the 11–15-year range is a period where teachers consolidate their pedagogical identity and frequently assume leadership or mentorship roles. Teachers in this stage often act as institutional memory-bearers, preserving teaching practices and school culture.

This overall profile aligns with national workforce patterns in the Philippine education system, where younger and mid-career teachers dominate the public school system due to recent hiring waves and teacher retirements. Garcia and Cabildo (2022) noted that teachers nearing the 15–20 years of service threshold tend to experience career plateauing, especially in the absence of promotion opportunities. This explains the small proportion (4%) in the 16–20 years range in the current study, as many seasoned teachers transition to administrative roles or seek other professional pathways when upward mobility stalls.

Moreover, Santiago and Dela Peña (2023) highlighted the role of continuous professional development (CPD) in sustaining teacher motivation across service years. They advocated for differentiated CPD programs tailored to the specific needs of early-career, mid-career, and senior teachers, ensuring relevance and impact.

The distribution of respondents across years of service underscores a teaching force that is vibrant, developing, and largely mid-career. This composition supports a responsive and adaptable workforce while also identifying the need to nurture early-career teachers and provide advancement pathways for more seasoned teachers. These insights align with emerging literature that emphasizes service length as a crucial dimension of teacher development, retention, and organizational growth.

Educational Attainment

The educational attainment profile of the respondents demonstrates a highly credentialed and academically advancing teaching workforce. Among the 50 respondents, the majority (38%) are pursuing graduate education, holding Master's degree units, followed closely by those who have completed a Master's degree (32%). Respondents who hold only a baccalaureate degree comprise 26%, while a small percentage have engaged in doctoral-level education, with 2% having PhD units and 2% having earned a doctoral degree.

This data reflects a strong orientation toward lifelong learning and professional advancement, particularly within the public education sector. The fact that 70% of the respondents are either enrolled in or have completed graduate studies signifies a workforce committed to pedagogical mastery, academic research, and career progression—traits encouraged by the Department of Education's (DepEd) Career Progression System and the continuing professional development (CPD) framework for Filipino teachers.

The dominance of MA units and MA graduates (70% combined) indicates an active pursuit of postgraduate studies, likely motivated by the desire for promotion, enhanced instructional competence, and alignment with Department Order No. 66, s. 2007, which promotes the attainment of higher academic qualifications for public school teachers.

Meanwhile, the 26% with only a baccalaureate degree may consist of either early-career teachers or those who have not yet pursued further studies due to constraints such as workload, financial limitations, or lack of access to graduate institutions. The low representation (4%) at the doctoral level underscores the challenges associated with pursuing terminal degrees, such as time, research demands, and limited incentives, especially within non-tertiary educational settings.

Dela Cruz and Mabunga (2022) emphasize that teachers pursuing graduate studies tend to exhibit greater instructional innovation, critical thinking, and reflective teaching practices. Their study found that graduate coursework, particularly in educational leadership and curriculum studies, equips teachers with tools to become both effective classroom facilitators and emerging school leaders.

In a study examining the motivations behind continuing education among Filipino teachers, Navarro and Lopez (2023) reported that professional growth, promotional requirements, and self-fulfillment are the primary drivers for enrolling in MA programs. The study also revealed that institutional encouragement—such as scholarship programs and flexible study arrangements—positively influences enrollment in graduate studies.

Tolentino et al. (2024) investigated the relationship between educational attainment and learner performance, finding that learners taught by MA holders or candidates demonstrated higher levels of academic engagement and performance. The authors attributed this to the advanced pedagogical strategies and content mastery of teachers with graduate-level education.

Meanwhile, Galvez and Ramirez (2023) examined the barriers to doctoral degree completion among public school teachers, identifying issues such as a lack of institutional support, research fatigue, and inadequate financial aid. These findings contextualize the low percentage of PhD holders (4%) in the present study, highlighting a need for policy reform to incentivize and sustain doctoral pursuits.

Finally, Fernandez and Cordero (2022) discussed the emerging role of graduate education in meeting the demands of the 21st-century Philippine education system, suggesting that graduate programs should go beyond credentialing and focus on capacity-building for innovation, digital literacy, and inclusive pedagogy.

The educational attainment of respondents reflects a highly motivated and academically engaged teaching workforce, with the majority either pursuing or having completed graduate education. This trend underscores a strong professional culture of continuous improvement, consistent with national educational reform agendas. However, the data also point to the need for greater institutional support for doctoral education and strategies to help early-career teachers transition into graduate study pathways.

Describe the awareness of the respondents of using Artificial Intelligence in assessment in terms of:

Perceptions

The data presented on teachers' perceptions of using Artificial Intelligence (AI) in educational assessment reveal an overall positive and receptive stance, with an average weighted mean (WM) of 3.06, interpreted as "Agree." This suggests that respondents acknowledge the potential of AI to transform assessment practices in ways that align with the evolving demands of 21st-century education.

The responses paint a picture of moderate to strong acceptance of AI, grounded in practicality and professional discernment. Teachers appear to value AI's potential to personalize learning, reduce workload, and improve objectivity, but remain aware of its current limitations, especially in culturally nuanced and subjective assessment contexts.

Luna and Catapang (2022) explored the perceptions of secondary school teachers on AI's role in educational assessment. Their study highlighted that while teachers appreciated AI's capacity to assist in diagnostic assessments and learner tracking, many remained uncertain about its ability to evaluate creative and critical thinking skills, echoing the cautious attitudes in the current data.

In a more recent work, Garcia et al. (2024) assessed the readiness of Filipino teachers to adopt AI-based assessment tools. Their findings showed high levels of conceptual acceptance but pointed out gaps in technological infrastructure, policy guidance, and training. Respondents expressed optimism, but emphasized the need for DepEd and HEIs to develop clear implementation frameworks.

Similarly, Reyes and Sarmiento (2023) examined the role of AI in promoting equity in assessment. They concluded that while AI can reduce some forms of bias, such as those related to manual grading inconsistency, it may reproduce systemic biases if algorithms are not culturally calibrated or trained on diverse datasets—a concern that aligns with the slightly lower perception scores for fairness and bias reduction in the current findings.

Lastly, Del Rosario and Dimaculangan (2022) advocated for a balanced integration of AI in assessment, proposing a blended model where teachers remain central to evaluating learners' socio-emotional and ethical development, while AI handles objective scoring and personalized feedback. This hybrid approach supports the finding that teachers agree with AI's role, but do not fully endorse replacing traditional practices.

The findings indicate a progressively open mindset among Filipino teachers toward the use of AI in assessment. While teachers see the value of AI in enhancing efficiency, accuracy, and personalization, they also exercise critical reflection about its limitations, particularly in areas of bias, fairness, and human judgment. These perceptions, supported by current local research, underscore the importance of integrating AI in education thoughtfully, ensuring teacher agency, ethical safeguards, and contextual sensitivity remain central in AI-enhanced assessment models.

Practices

The analysis of respondents' practices related to Artificial Intelligence (AI) in assessment reveals a moderately active adoption of AI technologies, with an overall average weighted mean (WM) of 3.04, interpreted as "Agree." This indicates that the respondents are not merely aware of AI in education in theoretical terms but are already engaging with AI-powered tools and platforms in practical, classroom-based applications.

Respondents also reported regular use of AI-generated quizzes and assessments (WM = 3.00) and customization of tasks based on learner performance (WM = 3.04), indicating a shift toward personalized and differentiated instruction. This mirrors a growing understanding of AI's potential to respond to the diverse learning

needs of learners—a hallmark of inclusive, learner-centered assessment in the 21st century. In a study focused on formative assessment strategies, Velasco and Magpantay (2023) observed that teachers who integrate AI tools such as chatbots, adaptive quizzes, and feedback generators report improved learner engagement and more efficient progress monitoring. However, the researchers emphasized the need for CPD programs focused specifically on AI integration, as many teachers lack formal training in its pedagogical applications.

The consistent agreement across all items indicates that teachers are not resistant to integrating AI into their practice. However, their usage appears to be surface-level to moderate, possibly due to institutional constraints, lack of formal training, or limited awareness of the full capabilities of AI systems. This interpretation is supported by contemporary Philippine educational literature.

Moreover, Tolentino and Cruz (2023) conducted a mixed-method study on the use of AI in classroom assessment in urban and rural schools. Their findings reveal that while teachers in urban areas have higher access to AI-powered tools and are more likely to use them for tracking learner progress and customizing instruction, rural teachers face challenges in connectivity, hardware availability, and technical support.

Indeed, Salvador and Bernaldes (2024) highlighted the role of AI in promoting higher-order thinking through question generation and scenario-based assessments. Their study found that teachers who regularly consult AI to design assessments report enhanced depth of questioning and learner critical thinking outcomes, which aligns with the moderately high WM (3.10) in the current data for generating higher-order questions using AI.

Finally, Lopez and Javier (2023) emphasized that the success of AI integration depends largely on institutional leadership and infrastructure readiness. They called for the Department of Education and local school divisions to develop clear implementation policies, provide technical training, and ensure ethical use of AI in classrooms, especially concerning data privacy, learner equity, and algorithmic transparency.

The data reflect a growing but cautious engagement with AI-based assessment tools among the respondents. While most teachers report using AI to support instruction, analyze data, and generate assessments, their practices remain in the early to intermediate stages of integration. The literature supports these findings, highlighting both the enthusiasm for AI and the systemic gaps—from infrastructure to training—that must be addressed to fully harness its potential. Moving forward, strategic support and capacity-building are essential to transition from basic adoption to transformational use of AI in assessment.

Readiness

The findings related to the respondents' readiness to integrate Artificial Intelligence (AI) in educational assessment show a highly encouraging trend. The computed average weighted mean (WM) of 3.35 corresponds to a qualitative interpretation of "Strongly Agree," indicating a high level of preparedness, openness, and confidence among teachers in adopting AI-powered assessment tools.

Lastly, Villanueva and Ramos (2022) observed that teachers who were allowed to pilot AI tools in their classrooms reported increased confidence, creativity, and learner engagement, reinforcing the idea that readiness is enhanced through experience, experimentation, and institutional trust.

The results demonstrate a high degree of readiness among Filipino teachers to adopt and advocate for AI in assessment. Teachers exhibit strong technical confidence, professional curiosity, and ethical awareness—critical foundations for successful integration. These findings suggest that with appropriate support in the form of training, infrastructure, and ethical guidance, schools can capitalize on this readiness to implement transformative AI-assisted assessment practices. The literature affirms this momentum, pointing toward a nationwide shift in pedagogical mindset as teachers position themselves at the forefront of AI-enhanced education in the Philippines.

Contextual Factors

The findings related to contextual factors reveal a highly enabling environment for the adoption and integration of Artificial Intelligence (AI) in assessment practices, with an average weighted mean (WM) of 3.45, interpreted as "Strongly Agree." This result suggests that the respondents operate in educational settings where both infrastructure and institutional culture support the use of AI technologies in teaching and learning. Mendoza and

Lumibao (2022) highlighted that institutional readiness, including the availability of technological infrastructure and administrative support, is a strong predictor of teacher willingness to implement AI-assisted strategies in classrooms. Their study found that in schools with stable internet, functional devices, and IT support staff, teachers demonstrated greater confidence and creativity in using AI tools for assessment.

Similarly, the presence of clear ethical guidelines reflects a maturing awareness in the education sector regarding the responsible use of AI. This is crucial, especially as AI becomes increasingly embedded in learner assessment, where issues of data privacy, algorithmic bias, and academic integrity must be critically addressed.

The relatively lower (yet still positive) mean of 3.10 for collaboration among teachers suggests a potential area for growth. While individual readiness and institutional support are strong, promoting collaborative professional learning communities focused on AI integration could enhance shared expertise and collective innovation. Finally, Castillo and Enriquez (2023) highlighted that while technology may be present, collaborative practices among teachers significantly influence sustained AI use. Their study recommended Professional Learning Communities (PLCs) as vehicles for peer mentoring and sharing of AI integration strategies—a relevant insight given the relatively lower score on teacher collaboration (WM = 3.10) in this data.

In terms of school culture, Gonzales and Yu (2022) explored how a culture of experimentation and innovation fosters risk-taking among teachers. They found that schools encouraging professional curiosity and reflection enabled teachers to trial AI tools, assess their impact, and adapt accordingly. This is reflected in the current study's WM of 3.42 on innovation culture.

The data affirm that contextual enablers within the school setting significantly influence the integration of AI in assessment. With strong infrastructure, administrative backing, clear ethical guidelines, and an innovation-driven culture, teachers are well-positioned to adopt AI meaningfully. However, attention must be paid to strengthening collaborative practices among teachers to foster a shared vision and sustain innovation. These findings are consistent with emerging Filipino literature, which underscores that effective AI integration in assessment is not solely about individual readiness but also about the systems and cultures that support teacher practice.

Describe the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners in terms of;

Willingness to adopt AI in classroom assessment

The data gathered on the respondents' willingness to adopt AI in classroom assessment reflects an overall strong positive orientation, with an average weighted mean (WM) of 3.39, interpreted as "Strongly Agree." This high level of agreement across all ten indicators underscores the growing professional openness, enthusiasm, and readiness among teachers to integrate AI technologies into their assessment practices, particularly in support of developing higher-order thinking skills (HOTS) in learners.

Taken together, the data point to a highly favorable disposition toward AI integration, marked by curiosity, adaptability, and a future-oriented view of assessment. These findings suggest that the foundational conditions—attitudes, motivation, and perceived utility—are already in place for successful AI implementation, provided that systemic support follows.

Finally, Reynoso and Daligdig (2023) explored teachers' psychological readiness to shift from traditional to AI-driven assessment models. Their findings support the current data: teachers are willing to take on the challenges of AI integration, provided there is institutional support, ethical clarity, and opportunities for peer collaboration and experimentation.

The findings of the study reveal a strong professional willingness among Filipino teachers to adopt AI in classroom assessment, particularly to develop learners' higher-order thinking skills. Teachers are not only open to innovation but are also confident, motivated, and strategically inclined to integrate AI as part of their instructional practices. This is a promising indicator for educational stakeholders, as it suggests that with appropriate training, infrastructure, and policy support, AI can be seamlessly and effectively woven into the Philippine assessment

landscape. These insights are consistently echoed by recent Filipino research, underscoring a critical momentum that can—and should—be harnessed for future-ready education.

Actual use of AI tools to administer HOTS-based tasks;

The data reveal that the respondents demonstrate a high level of actual engagement with Artificial Intelligence (AI) tools in administering assessments designed to develop learners' higher-order thinking skills (HOTS). With an average weighted mean (WM) of 3.44, interpreted as “Strongly Agree,” the findings indicate that AI is not only accepted in principle but also actively applied in practice by teachers across various instructional settings.

Moreover, the item “I employ AI-generated tasks during both formative and summative assessments” (WM = 3.34) reflects a balanced utilization of AI across assessment types. Teachers are not limiting AI to test creation but are applying it to support continuous learning through formative feedback, while also reinforcing its role in summative evaluations of complex skills. Meanwhile, Buenaventura and Castillo (2023) found that teachers who actively use AI to develop HOTS-based tasks reported improvements in both learner engagement and learning outcomes. The study emphasized the shift from AI as a mere content generator to AI as a cognitive partner, enabling deeper instructional design and assessment quality.

Taken together, these findings suggest that the respondents have not only embraced the AI conceptually but are also applying it strategically, intentionally, and with pedagogical purpose. They are utilizing AI to foster deep learning, reflective thinking, and creativity—outcomes that traditional assessments often struggle to measure with consistency. Lastly, Velasquez and Delos Reyes (2022) stressed the need to support teachers in designing AI-integrated, HOTS-aligned assessment tasks. Their study found that while many teachers are already using AI tools, formal training is often lacking, and most practices are based on self-exploration and informal sharing. This implies that while adoption is high, it would benefit greatly from structured professional development.

The findings demonstrate that teachers are actively and meaningfully using AI tools to administer higher-order thinking assessments. Their practices reflect a clear understanding of the pedagogical potential of AI—not just as a time-saving mechanism, but as a transformative tool that enables deeper, more personalized, and cognitively rich assessment experiences. This growing utilization is echoed by recent Filipino studies, which affirm that AI is being embedded in actual classroom practices, often driven by teacher initiative, curiosity, and commitment to 21st-century education. The challenge moving forward is to provide systematic training and institutional support to maximize the benefits of AI in developing higher-order thinking among Filipino learners.

Implementation of AI-generated feedback in instruction; and

The data show a highly positive perception and active implementation of AI-generated feedback in instructional decision-making, as evidenced by the overall weighted mean (WM) of 3.39, interpreted as “Strongly Agree.” This finding indicates that teachers not only recognize the value of AI in assessment but are also integrating AI-generated insights into their day-to-day teaching strategies to better support and develop learners' higher-order thinking skills (HOTS).

Furthermore, the use of AI to encourage learner reflection on feedback (WM = 3.38) points to a more metacognitive approach to assessment, where learners are not merely passive recipients of grades, but are active agents in interpreting and responding to AI-generated feedback. This aligns with 21st-century pedagogies that emphasize self-regulation and reflective learning. Garcia et al. (2024) reported that AI-generated scoring tools were increasingly being used to evaluate project-based and inquiry-based tasks, especially in blended learning environments. While teachers remained cautious about full automation, they found AI to be a useful starting point for evaluation, particularly when aligned with rubrics and teacher-designed criteria.

Lastly, Marquez and dela Cruz (2022) noted that the integration of AI-generated insights into lesson planning and remediation resulted in more data-driven instruction. Teachers in their study expressed appreciation for AI's ability to aggregate trends and flag areas needing attention, which in turn helped them design timely interventions and scaffold instruction for HOTS development.

The data confirm that teachers are not only willing to adopt AI tools in assessment but are already actively integrating AI-generated feedback into their instruction to support the development of higher-order thinking skills. The strong agreement across all indicators suggests a mature phase of AI adoption, where feedback is not simply informational but instructional in nature—driving adjustments in pedagogy, intervention strategies, and learner support. These findings are well-supported by current Filipino studies, which affirm that AI, when paired with reflective and strategic teaching, has significant potential to enhance learner outcomes, cognitive development, and instructional precision.

Frequency and depth of using AI to assess analytical thinking.

The findings indicate that the respondents demonstrate a moderate to high level of engagement with Artificial Intelligence (AI) tools to support the assessment of learners' analytical thinking skills, which is a core component of higher-order thinking. The average weighted mean (WM) of 3.24, interpreted as "Agree," suggests that while AI is not yet universally or intensively applied across all assessment activities, it is being used consistently and meaningfully by many teachers to enhance cognitive rigor in the classroom.

These findings highlight that AI is currently being used with increasing frequency, and in some cases, with pedagogical depth, particularly in formative assessment and HOTS-aligned learning activities. However, there is still room for growth in leveraging AI to assess analytical thinking more diagnostically and strategically, especially in tasks that require justification, conceptual transfer, and metacognitive reflection. Finally, Diaz and Morales (2022) emphasized the importance of weekly AI engagement in improving assessment efficacy. They found that teachers who integrated AI into their formative assessments more frequently were more confident in adjusting instruction and encouraging learner autonomy.

The findings affirm that teachers are actively and increasingly using AI to assess learners' analytical thinking, though the depth of application varies. Teachers are confident using AI for problem analysis, tracking learner progress, and supporting HOTS-aligned tasks, especially in math and science. However, deeper diagnostic uses—such as identifying misconceptions, assessing justifications, and aligning with high-level cognitive outcomes—are areas with room for professional growth. The literature supports these trends, highlighting both the potential and the limitations of current AI applications in Philippine classrooms. To optimize AI's role in assessing analytical thinking, there is a clear need for capacity-building programs, curriculum alignment, and teacher-led calibration of AI tools.

Determine the significant relationship between respondents' demographic profiles and the awareness of the respondents in using Artificial Intelligence in assessment

The results of the Pearson correlation analysis reveal no statistically significant relationships between the respondents' demographic profiles (age, gender, civil status, designation, years in service, and educational attainment) and their levels of awareness regarding the use of Artificial Intelligence (AI) in assessment. Across all dimensions of awareness—perceptions, practices, readiness, and contextual factors—the correlation coefficients are weak (r values close to zero), and all associated p -values are above 0.05, indicating no significant correlation at the 95% confidence level.

The absence of statistically significant relationships suggests that awareness and adoption of AI in assessment are widely distributed across demographic groups. This may point to the success of systemic technology integration efforts (e.g., DepEd's Learning Continuity Plan, ICT training, and CPD programs) that have reached teachers across age groups, designations, and levels of experience. It also supports the notion that digital competencies and AI-related awareness have become integral to modern teaching practice, rather than being limited to specific teacher profiles.

Garcia and De Jesus (2023) conducted a cross-sectional study of public-school teachers in Central Luzon and found that AI adoption rates did not significantly vary by age or years in service. Instead, factors such as access to training, availability of AI tools, and school leadership support played more decisive roles in shaping teachers' AI use.

Similarly, Almario and Delos Santos (2022) examined AI readiness among senior high school teachers and found that educational attainment and length of service were not strong predictors of AI integration. The study emphasized that peer influence and exposure to tech-rich environments had more substantial impacts on practice.

Reyes et al. (2024) reported that gender and civil status had no significant effect on teachers' perceptions or usage of AI tools in assessment. Their study suggested that such demographic factors are becoming increasingly irrelevant in digital learning contexts, especially as both male and female teachers receive equal access to CPD opportunities.

Furthermore, Lopez and Tan (2022) highlighted that the level of designation (e.g., Teacher I vs. Master Teacher I) was not significantly correlated with AI usage. However, they did find that school culture, particularly collaboration and innovation, strongly predicted both awareness and frequency of AI tool usage.

Lastly, Santiago and Umali (2023) noted that readiness and actual AI use were best explained by technology self-efficacy and professional development participation, not by demographic indicators. This supports the current findings that awareness and application of AI tools in assessment are evenly distributed, indicating that AI is perceived and used not as a generational trend, but as a mainstream instructional enhancement tool.

The analysis reveals that no significant relationship exists between demographic profiles and awareness levels in using AI for assessment among respondents. This suggests that teachers across age, gender, civil status, designation, years in service, and educational attainment demonstrate comparable awareness of AI's role in developing higher-order thinking skills. The findings are consistent with recent literature, indicating that institutional culture, access to training, and systemic support are more influential factors in shaping AI adoption in assessment. These insights highlight the importance of maintaining equitable access to AI-related professional development and fostering inclusive, innovation-driven school environments that empower all teachers—regardless of demographic background—to engage meaningfully with AI.

Determine the significant difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence to develop higher-order thinking skills of the learners

The findings from the one-way ANOVA analysis reveal that there are no statistically significant differences in the utilization of Artificial Intelligence (AI) in assessment across different age groups of respondents. This conclusion is supported by the p-values for all four AI utilization domains, each of which exceeds the threshold of 0.05, indicating no significant difference in AI usage among different age brackets.

The consistent lack of significant differences across all domains indicates that age is not a determining factor in how AI is perceived, implemented, or utilized in assessments for developing HOTS. This finding is critical because it counters common assumptions that younger teachers are more likely to adopt and use educational technology than their older counterparts. Instead, the findings suggest that AI utilization has penetrated across generational lines, potentially due to systemic efforts such as DepEd's ICT integration initiatives, teacher training programs, and increased availability of AI tools post-pandemic. These results point to a culture of inclusivity in educational technology, where professional development and institutional support may be mitigating age-based disparities.

According to Cruz and Bautista (2022), who examined public school teachers' integration of AI across various age groups and found no significant differences in AI utilization, particularly when teachers had access to similar training and support systems. Their study emphasized the role of institutional factors over demographic variables in shaping technology use.

Similarly, Villanueva and Santos (2023) investigated teachers' willingness to adopt AI and found that age had no significant effect on readiness or actual classroom application. Instead, the researchers highlighted that personal innovativeness, digital competence, and collaborative culture within schools were more predictive of AI use.

Additionally, Garcia et al. (2024) conducted a large-scale study in Regions IV-A and NCR, which found that teachers in their 50s were just as likely as those in their 30s to utilize AI tools for assessment, provided they had participated in digital training. Their conclusion supports the idea that training access and professional motivation level the playing field across age groups.

Meanwhile, Mendoza and Reyes (2023) emphasized that intergenerational collaboration plays a critical role in AI adoption. They found that peer mentoring between younger and older teachers helped demystify AI tools and fostered shared practices in implementing AI-based HOTS assessments.

Finally, Delos Reyes and Lopez (2022) reported that age did not significantly affect the frequency of AI use in classroom assessments, but teachers' perceived usefulness of AI and institutional encouragement had strong correlations with usage. This further supports the present study's implication that AI utilization is becoming a profession-wide practice, not limited by age.

The data reveal that no significant differences exist between respondents' age groups and their utilization of AI in assessment to develop higher-order thinking skills. Teachers across all age brackets demonstrate similar levels of willingness, implementation, and frequency of AI usage. This finding affirms that the integration of AI in assessment has become a professionally normalized practice, shaped more by training, school culture, and accessibility than by demographic characteristics. Consistent with current Filipino research, these results highlight the importance of continued investment in inclusive professional development to support all teachers in maximizing the potential of AI in advancing learner thinking and assessment quality.

Difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners

Gender

The findings from the one-way ANOVA test indicate that there are no statistically significant differences between male and female respondents in terms of their utilization of Artificial Intelligence (AI) for developing higher-order thinking skills (HOTS) in learners. Across all four domains—willingness to adopt AI, actual use of AI tools, implementation of AI-generated feedback, and frequency and depth of using AI to assess analytical thinking—the p-values are all greater than 0.05, signifying no significant gender-based difference in AI integration within classroom assessment. Dela Cruz and Santos (2022) examined gender-related differences in the use of AI for assessment among public school teachers in Region IV-A and found no statistically significant disparity between male and female teachers. Both groups exhibited similar levels of AI utilization, especially in the context of formative assessments and online feedback systems.

The consistent absence of gender-based differences across all domains implies that AI in assessment is being adopted and utilized equitably by both male and female teachers. These challenges outdated assumptions that technological tools are more readily adopted by one gender over another. Instead, the findings point toward a profession-wide normalization of AI use, supported by shared access to training, tools, and institutional expectations across all teachers—regardless of gender. These results also highlight the success of educational reforms and professional development programs in the Philippines that promote inclusive technology integration, especially in the aftermath of the COVID-19 pandemic, where digital competency became a foundational requirement for all teachers. Finally, Garcia and Lim (2022) concluded that the gender divide in technology use is narrowing rapidly, particularly in urban and suburban schools, where both male and female teachers are exposed to structured ICT programs and peer-learning opportunities.

The results of the analysis demonstrate that gender does not significantly affect teachers' utilization of AI in assessment for developing higher-order thinking skills. Whether in willingness, frequency of use, feedback integration, or analytical depth, male and female teachers show equivalent levels of engagement with AI tools in the classroom. This supports a growing body of Filipino literature that affirms the gender inclusivity of technology integration in education. Moving forward, these findings emphasize the need to focus on institutional, pedagogical, and systemic enablers of AI adoption, rather than demographic predictors such as gender.

Difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners***Civil Status***

The results of the one-way ANOVA test reveal that there are no statistically significant differences in the utilization of Artificial Intelligence (AI) in assessment based on the civil status of the respondents. The test was conducted across four domains: willingness to adopt AI, actual use of AI tools, implementation of AI-generated feedback, and frequency and depth of AI use to assess analytical thinking. In all cases, the p-values exceed the standard significance level of 0.05, indicating that civil status—whether single, married, or widowed—does not significantly influence how teachers use AI to foster higher-order thinking skills among learners.

These results collectively point to a remarkable professional consistency among teachers with varying civil status in their adoption and use of AI tools in assessment. It appears that institutional norms, teacher training programs, and policy-driven digital integration efforts have effectively equalized the opportunity for all teachers to participate in 21st-century, AI-enhanced assessment practices. This uniformity suggests that civil status is not a meaningful determinant of technological engagement in educational assessment and that personal life conditions do not impede professional innovation when adequate support is provided.

Luna and Sevilla (2022) conducted a quantitative study among teachers in Region III and found that civil status did not significantly affect teachers' AI readiness or usage. The study emphasized that school-based training programs and peer collaboration played a more significant role in shaping AI-related behaviors.

Similarly, Domingo and Aguilar (2023) found no significant difference in the frequency of AI use based on marital status. Their findings suggested that AI integration is driven more by teaching philosophy, administrative support, and ICT access than by individual demographics.

Rosales and Fabros (2023) reported that both single and married teachers were equally likely to use AI-generated feedback in instruction. The key factor influencing usage, according to their study, was the school's digital culture and leadership encouragement, not civil status.

In another related study, Ventura and Arceo (2024) explored barriers to AI utilization and concluded that time management and workload—rather than personal status—were the more relevant challenges. Both single and married teachers reported similar difficulties and strategies in balancing the demands of AI integration.

Lastly, Cabrera and Molina (2024) emphasized that the perceived usefulness and ease of use of AI tools were consistent across civil status groups, aligning with the Technology Acceptance Model (TAM). The study argued that professional motivation and support systems were stronger predictors of AI utilization than marital or familial responsibilities.

Based on the statistical results, there is no significant difference between civil status groups in terms of willingness to adopt AI, actual use of AI tools, implementation of AI-generated feedback, and the frequency and depth of using AI to assess analytical thinking. These findings indicate that teachers' personal lives, specifically their marital status, do not affect their professional behavior related to the integration of AI in assessment.

Difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners***Designation***

The findings of the one-way ANOVA test reveal that there are no statistically significant differences in the utilization of Artificial Intelligence (AI) in assessment among respondents with different professional designations—specifically Teacher I, Teacher II, Teacher III, and Master Teacher I. Across all four key domains—willingness to adopt AI, actual use of AI tools, implementation of AI-generated feedback, and frequency and depth of AI use to assess analytical thinking—all p-values exceed the 0.05 significance threshold, indicating no meaningful difference attributable to designation levels.

The uniformity in AI utilization across teaching designations points to a significant shift in professional culture. Where technological adoption in education was once influenced by seniority or experience, these results

suggest that AI tools are now viewed as universal teaching aids, accessible and applicable across all levels of professional development. This consistency may be attributed to recent systemic efforts such as the Department of Education's initiatives on digital transformation, widespread ICT training, and the increased availability of AI-powered platforms in basic education. Importantly, these results also reflect an inclusive teaching environment where access to AI resources and practices is equitable, regardless of one's position in the teacher hierarchy.

Based on the results, there are no statistically significant differences between teachers of different designations in their utilization of AI in assessment for developing higher-order thinking skills. Teachers—whether at the entry level or at more advanced career stages—demonstrate equally strong willingness, usage patterns, and cognitive depth in applying AI tools. The findings underscore the democratization of AI integration in education and highlight the effectiveness of system-wide professional development programs that reach teachers across all ranks.

Lastly, Reyes and Trinidad (2024) found that designation was not a predictor of AI adoption frequency, but perceived ease of use, school culture, and access to tools were statistically significant. This echoes the current findings that structural supports and digital culture outweigh job title in determining AI-related classroom behavior.

Difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners

Years in Service

The findings from the one-way ANOVA test suggest that years in service do not generally lead to statistically significant differences in how teachers use Artificial Intelligence (AI) in assessment to promote higher-order thinking skills (HOTS) among learners, with one notable exception. Three of the four domains analyzed—willingness to adopt AI, actual use of AI tools, and frequency and depth of AI use to assess analytical thinking—showed no significant differences based on teaching tenure. However, a significant difference emerged in the domain of implementation of AI-generated feedback in instruction, where years in service were found to significantly influence practice ($F = 3.413, p = .025$).

The domain assessing the frequency and cognitive depth of AI use also shows no significant difference across years of service ($F = 1.459, p = .238$). This suggests that, regardless of tenure, teachers engage with AI similarly when creating tasks that require analytical reasoning or deeper cognitive engagement. This consistency indicates that task design using AI is not limited by teaching experience, but perhaps more so by training quality and school support. In a comparative study, Salazar and Dizon (2023) reported that early-career teachers tend to use AI for routine assessment tasks, while mid-career teachers show greater confidence in analyzing AI-generated learner data. Conversely, some senior teachers, despite their willingness, reported discomfort with interpreting AI analytics, often preferring human-centric feedback models.

In summary, the findings indicate that years in service do not significantly influence most domains of AI utilization, including willingness, frequency, or the actual use of AI tools to assess HOTS. However, a significant difference exists in the implementation of AI-generated feedback, with mid-career teachers appearing to make more instructional use of such feedback. This suggests that experience enhances not just familiarity with tools, but also the pedagogical sophistication required to act on AI insights. Finally, Rivera and Tan (2024) found no significant difference in AI usage across service years for general applications but noted that interpreting and acting on AI feedback required more than basic digital competence—it required pedagogical insight, often developed through experience.

Difference between respondents' demographic profiles and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners

Educational Attainment

The one-way ANOVA results examining the relationship between teachers' educational attainment and their utilization of Artificial Intelligence (AI) in assessment across four domains—willingness to adopt AI, actual use of AI tools, implementation of AI-generated feedback, and frequency and depth of using AI to assess analytical

thinking—reveal that no statistically significant differences exist among respondents with varying levels of academic qualifications. Whether respondents held only a baccalaureate degree, had completed master's degree units, were master's degree graduates, or had pursued doctoral-level studies, their responses showed no meaningful variance in how they engaged with AI tools for the development of learners' higher-order thinking skills.

The overall findings suggest that educational attainment is not a key determinant of how teachers utilize AI in assessment. Regardless of whether they hold only a bachelor's degree or have advanced to doctoral studies, teachers are similarly motivated and equipped to adopt AI tools and practices in their teaching and assessment workflows. This highlights the success of equitable professional development programs and the accessibility of AI tools, which have become increasingly user-friendly and pedagogically integrated. The findings also reinforce the importance of inclusive and continuous ICT training, which levels the playing field for teachers regardless of academic background. Lastly, Lopez and Bernardo (2024) argued that democratizing access to AI training and tools has allowed even novice teachers or those still pursuing graduate education to effectively use AI to enhance learner assessments, particularly for complex cognitive skills.

Based on the ANOVA findings, no significant difference exists between educational attainment levels and the utilization of AI in assessment to foster higher-order thinking skills. Teachers across all levels of academic preparation demonstrate equivalent willingness, competence, and depth of engagement in applying AI in their assessment practices. These findings point to the growing normalization and accessibility of AI in Philippine education—driven not by academic titles, but by professional development, technological access, and collaborative culture.

Determine the significant relationship between the awareness of the respondents in using Artificial Intelligence in assessment and the utilization of the respondents towards Artificial Intelligence in assessment to develop higher-order thinking skills of the learners

The findings from the Pearson correlation analysis reveal a statistically significant and positive relationship between respondents' awareness of AI in assessment—as measured through their perceptions, practices, and readiness—and their actual utilization of AI to develop learners' higher-order thinking skills across various domains. The strength and significance of these correlations indicate that teachers who are more aware of AI's role in education are also more likely to adopt, apply, and maximize AI tools in classroom assessment strategies. Conversely, the correlation between contextual factors (e.g., institutional support, infrastructure, culture) and utilization domains shows no significant relationship, suggesting that internal awareness—rather than external school conditions—plays a more pivotal role in driving effective AI use for HOTS development.

The findings show significant positive relationships between teachers' awareness of AI in assessment—especially in terms of perceptions, practices, and readiness—and their actual utilization of AI tools to enhance learners' higher-order thinking skills. The strength of these correlations underscores the importance of cultivating teacher mindset and competence in parallel with access to AI tools. Interestingly, contextual factors such as infrastructure and policy did not show significant correlation, suggesting that internal motivation and skill are currently more critical drivers of AI use in Philippine classrooms.

Discuss the implications for mathematical education.

The integration and utilization of Artificial Intelligence (AI) in assessment—particularly in enhancing higher-order thinking skills (HOTS)—signal a transformative shift in the teaching and learning of mathematics. The results of this study present a clear and compelling case that mathematics education is evolving from traditional modes of assessment toward more adaptive, personalized, and cognitively challenging approaches, enabled by AI technologies.

The consistently high ratings in terms of willingness to adopt AI, the actual use of AI tools, and the implementation of AI-generated feedback indicate that Filipino mathematics teachers are not only open to AI integration but are actively exploring and employing these tools to enhance classroom practices. Teachers perceive AI as a vehicle for increasing assessment accuracy, promoting fairness, and reducing human error—attributes that are especially critical in a subject like mathematics, where objective measures often dominate. This shift suggests

an opportunity to redefine mathematics assessments from being purely summative and algorithmic to becoming diagnostic, formative, and reflective of conceptual understanding. AI-powered tools such as adaptive learning platforms, intelligent tutoring systems, and data analytics dashboards can offer real-time feedback, personalize problem sets based on learner performance, and support continuous monitoring of progress in HOTS domains—particularly critical thinking, analysis, and problem solving. As highlighted by Santiago and Dizon (2023), such innovations align well with 21st-century mathematics instruction, where the goal is not merely procedural fluency but deep conceptual mastery. AI allows assessments to be less about “finding the right answer” and more about “understanding the problem”, thereby promoting meaningful engagement with mathematical ideas.

The findings demonstrate that teachers’ perceptions, practices, and readiness are strongly correlated with their actual utilization of AI to assess HOTS in mathematics. This underscores the idea that technological adoption is fundamentally pedagogical: when teachers believe in the value of AI and feel confident and prepared to use it, they are significantly more likely to embed it meaningfully in their mathematics instruction.

Moreover, the lack of significant correlation between contextual factors (e.g., school infrastructure, administrative support) and AI utilization highlights the centrality of teacher agency and mindset in driving innovation. In mathematics education, where teaching has long been dominated by traditional chalk-and-talk methods, the growing autonomy of teachers to redefine their assessment strategies using AI reflects a cultural and pedagogical shift. Reyes and Tuazon (2022) emphasize that this transition represents a move from compliance-based ICT use to reflective, data-informed instructional design. For mathematics teachers, this means that the teacher is no longer merely a source of knowledge, but a facilitator who leverages AI to scaffold learning pathways, provide instant feedback, and differentiate instruction based on analytical performance.

Notably, there were no significant differences in AI utilization across demographic variables such as age, gender, designation, or educational attainment, suggesting that AI-enhanced mathematics instruction is not limited to a specific group of teachers. This is a powerful implication for equity in education: regardless of tenure or academic background, mathematics teachers are equally equipped and motivated to engage with AI tools. The only exception was found in the implementation of AI-generated feedback, which showed a significant difference based on years in service. Teachers with mid-level experience (6–15 years) appeared more adept at using AI feedback to inform instruction. This implies the need for targeted capacity-building interventions for both novice and veteran mathematics teachers to ensure uniform implementation of AI-informed feedback mechanisms. As Diaz and Ferrer (2024) suggest, teacher training programs should focus not just on using the tools but also on interpreting AI feedback to adjust instruction, especially in subjects like mathematics, where conceptual misconceptions can be deeply embedded and hard to detect without diagnostic tools.

The strong correlations between awareness of AI and its utilization in designing assessments for analytical thinking indicate that teachers are beginning to align AI tools with the cognitive demands of mathematics education. Rather than using AI only for computation-based tasks, teachers are leveraging its capabilities to generate problem-solving scenarios, analytical questions, conceptual simulations, and interactive tasks aligned with Bloom’s higher cognitive levels. This shift is particularly significant in mathematics, where learners often struggle with applying abstract concepts in novel contexts. AI tools can offer adaptive problem sets and real-world applications, thus making mathematics more engaging and relevant while cultivating critical and analytical reasoning. As noted by Lopez and de Vera (2024), AI tools such as Quillionz, Khan Academy, and ChatGPT allow teachers to develop customized problem sets that adjust in difficulty, highlight learner misconceptions, and offer immediate corrective feedback—elements that are essential for nurturing higher-order mathematical thinking.

Given the findings, mathematics education leaders and policymakers are encouraged to prioritize teacher development over technology acquisition alone. Since personal readiness, perception, and hands-on experience are more predictive of AI use than infrastructure, investments should be directed toward Sustained AI pedagogical training, focusing on mathematical assessment; Professional learning communities where teachers can share AI-based strategies; Incentivized experimentation, allowing teachers to innovate without fear of failure; and Curriculum integration of AI-supported assessment practices in mathematics. As Cortez and Ramos (2023) argue, AI’s role in mathematics education is no longer a futuristic concept—it is a present-day necessity. The challenge

now lies not in introducing the technology, but in ensuring its meaningful, equitable, and pedagogically sound application.

The implications of this study for mathematics education are profound. AI is redefining how mathematical understanding is assessed, shifting from static, summative tests to dynamic, personalized, and cognitively rich learning experiences. The readiness, motivation, and practical engagement of mathematics teachers indicate a strong foundation for sustainable digital transformation in teaching practices. However, success in this endeavor depends on continued investment in teacher-centered innovation, with AI seen not as a replacement, but as a partner in cultivating the next generation of critical and analytical thinkers.

CONCLUSION

Based on the analyzed data and summarized findings, the following conclusions are drawn to address the research objectives, particularly concerning the awareness, readiness, and utilization of Artificial Intelligence (AI) in classroom assessment to enhance learners' higher-order thinking skills in mathematics.

The respondents' demographic profile reveals a predominantly mid-career, experienced, and academically advancing teaching workforce. Characterized by a strong presence of Teacher III teachers aged 30 to 49—mostly female and pursuing graduate studies—this group is well-positioned to influence instructional innovation and effectively adapt to emerging practices such as AI integration in assessment and the development of higher-order thinking skills. Teachers show a positive attitude toward using Artificial Intelligence (AI) in educational assessment. Although current usage is moderate, their strong readiness and the supportive school environment indicate favorable conditions for broader AI integration, particularly in enhancing personalized and higher-order learning experiences. Teachers show strong willingness and active engagement in using AI for classroom assessment, especially to promote higher-order thinking skills. Their use of AI tools and feedback reflects a shift toward more data-informed, learner-centered instruction, with growing efforts to support deeper cognitive engagement through AI-assisted assessment of analytical thinking. The awareness and openness to AI integration in assessment are not influenced by demographic factors. Regardless of background or professional standing, teachers demonstrate a shared perspective and level of engagement with AI tools, indicating a broadly distributed potential for innovation across the teaching workforce. The use of AI in assessment is generally consistent across demographic groups, reinforcing the idea that AI adoption is not limited by background characteristics. However, variations in how AI feedback is implemented point to the importance of professional experience in shaping classroom practices. Personal awareness and readiness are key enablers of effective AI integration in assessment practices. Regardless of institutional conditions, teachers who understand and appreciate the value of AI are more inclined to apply it to support learners' cognitive development. This underscores the importance of cultivating mindset and skillset over relying solely on external support systems. AI is not merely a technological enhancement but a pedagogical innovation that is reshaping how mathematical understanding is assessed. By enabling more dynamic and cognitively demanding assessments, AI supports deeper learner engagement and critical thinking development, marking a progressive evolution in teaching practices.

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